FORM PTO-1390 (REV 10-94) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 9320.127USWO

US APPLICATION NO (If known, see 37 C F R 1 5): Unknown 09/830232

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR99/02799	November 15, 1999	November 13, 1998

TITLE OF INVENTION

METHOD AND DEVICE FOR RECEIVING AT LEAST TWO RECEPTION PATHS, AND CORRESPONDING USE

APPLICANT(S) FOR DO/EO/US

LAUNAY et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. [X] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [ ] A SECOND of SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information: Specification as Amended; International Search Report; International Preliminary Examination Report; Form 1449, cited references

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Unknown 09/830232	PCT/FR99/02799	9320.127USWO

17. [X] The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a) (1)-(5)): Search Report has been prepared by the EPO or JPO **$860.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.492(a)(1)) **$690.00**		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) **$710.00**		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(3)) paid to USPTO **$1000.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	**$0**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	8 -20 =	0	X **$18.00**	**$0**	
Independent claims	2 -3 =	0	X **$80.00**	**$0**	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$260.00**	**$0**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction by 1/2 for filing by small entity, if applicable. Small entity status is claimed pursuant to 37 CFR 1.27				**$0**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			+	**$0**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	**$0**	
TOTAL FEES ENCLOSED =				**$860.00**	
				Amount to be: refunded	**$0**
				charged	**$0**

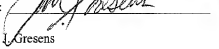
a. [X] Check in the amount of $860.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13-2725.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
John J. Gresens
MERCHANT & GOULD
P.O. Box 2903
Minneapolis, MN 55402-0903

SIGNATURE: 

NAME: John J. Gresens

REGISTRATION NUMBER: 33,112

S/N unknown PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	LAUNAY et al	Docket No.:	9320.127USWO
Serial No.:	unknown	Filed:	concurrent herewith
Int'l Appln No.:	PCT/FR99/02799	Int'l Filing Date:	November 15, 1999
Title:	METHOD AND DEVICE FOR RECEIVING AT LEAST TWO....		

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL669941693US
Date of Deposit: April 24, 2001
I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.
By: Yolanda Gray
Name: Yolanda Gray

PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

In connection with the above-identified application filed herewith, please enter the following preliminary amendment, which is based on the Article 34.2 amendments, based on claims amended in prosecution of the international application and published in the International Preliminary Examination Report, a copy of which is enclosed herewith (marked-up copy attached):

IN THE SPECIFICATION

A courtesy copy of the present specification is enclosed herewith. However, the World Intellectual Property Office (WIPO) copy should be relied upon if it is already in the U.S. Patent Office.

IN THE CLAIMS

Please amend the following claims:

3. (Amended) Reception device according to claim 1, characterized in that said adapted estimated value is computed as follows:

$$\hat{x}_{Adap,n} = \left(\sum_{i=1}^{N} cnfd_{i,n} \times \hat{x}_{i,n} \right) / \left(\sum_{i=1}^{N} cnfd_{i,n} \right)$$

where:

$\hat{x}_n$ is the estimated value of the symbol received on the path *i*;

$cnfd_{i,n}$ is the corresponding path confidence information element; and

N is the number of paths.

4. (Amended) Reception device according to claim 1, characterized in that, said adaptive confidence information element is computed as follows:

$$cnfd_{Adap,n} = \sum_{i=1}^{N} cnfd_{i,n}$$

where:

$cnfd_{i,n}$ is the confidence information element associated with the path *i*; and

N is the number of paths.

5. (Amended) Reception device according to claim 1, characterized in that it implements at least two antennas (101_1, 101_2), supplying distinct reception paths.

6. (Amended) Reception device according to claim 1, characterized in that each of said reception paths comprises a first module shaping and demodulating the received

signal and a second module determining said estimated path values and said corresponding confidence information elements,

said device furthermore comprising a single module supplied by said second modules, and providing especially for the combination (11) delivering said adapted estimated values and a weighted-input decoding (12) supplied by said adapted estimated values.

8. (Amended) Use of a device and/or of the method according to claim 1 and/or of the method for the reception of a multicarrier signal, formed by a set of carrier frequencies transmitted simultaneously, implementing at least two reception paths supplied with data flows, each conveying the same source symbols, each of said paths implementing a step of estimation of the transmission channel associating, with each source symbol received, an estimated path value and a corresponding path confidence information element,

a source symbol being conveyed by a subset of said set of carrier frequencies,

characterized in that it comprises:

- a combination step delivering:
- an adapted estimated value, obtained from said estimated path values in taking account of said path confidence information to weight said estimated path values ; and
- an adapted confidence information element with each of said adapted estimated values, as a function of said path confidence information elements,
- a step of weighted-input decoding, supplied by said adapted estimated values, for the reception of data belonging to at least one of the following applications:

- the broadcasting of digital television signals;
- the broadcasting of audio-digital signals;
- radio telephony;
- the transmission of data signals.

REMARKS

The above preliminary amendment is made to remove multiple dependencies from claims 3, 4, 5, 6 and 8.

Applicants respectfully request that the preliminary amendment described herein be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney-of record, John J. Gresens (Reg. No. 33,112), at (612) 371.5265.

Respectfully submitted,

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Dated: April 24, 2001

By _____
John J. Gresens
Reg. No. 33,112

JJG/tvm

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3. (Amended) Reception device according to [any of the claims 1 and 2] claim 1, characterized in that said adapted estimated value is computed as follows:

$$\hat{x}_{Adap,n} = \left(\sum_{i=1}^{N} cnfd_{i,n} \times \hat{x}_{i,n} \right) / \left(\sum_{i=1}^{N} cnfd_{i,n} \right)$$

where:

$\hat{x}_n$ is the estimated value of the symbol received on the path *i*;

$cnfd_{i,n}$ is the corresponding path confidence information element; and

N is the number of paths.

4. (Amended) Reception device according to [any of the claims 1 to 3] claim 1, characterized in that, said adaptive confidence information element is computed as follows:

$$cnfd_{Adap,n} = \sum_{i=1}^{N} cnfd_{i,n}$$

where:

$cnfd_{i,n}$ is the confidence information element associated with the path *i*; and

N is the number of paths.

5. (Amended) Reception device according to [any of the claims 1 to 4] claim 1, characterized in that it implements at least two antennas (101_1, 101_2), supplying distinct reception paths.

6. (Amended) Reception device according to [any of the claims 1 to 5] claim 1, characterized in that each of said reception paths comprises a first module shaping and demodulating the received signal and a second module determining said estimated path values and said corresponding confidence information elements,

said device furthermore comprising a single module supplied by said second modules, and providing especially for the combination (11) delivering said adapted estimated values and a weighted-input decoding (12) supplied by said adapted estimated values.

8. (Amended) Use of a device and/or of the method according to [any of the claims 1 to 6] claim 1 and/or of the method [according to claim 7] for the reception of a multicarrier signal, formed by a set of carrier frequencies transmitted simultaneously, implementing at least two reception paths supplied with data flows, each conveying the same source symbols, each of said paths implementing a step of estimation of the transmission channel associating, with each source symbol received, an estimated path value and a corresponding path confidence information element,

a source symbol being conveyed by a subset of said set of carrier frequencies,

characterized in that it comprises:

- a combination step delivering:
- an adapted estimated value, obtained from said estimated path values in taking account of said path confidence information to weight said estimated path values ; and
- an adapted confidence information element with each of said adapted estimated values, as a function of said path confidence information elements,

- a step of weighted-input decoding, supplied by said adapted estimated values, for the reception of data belonging to at least one of the following applications:
- the broadcasting of digital television signals;
- the broadcasting of audio-digital signals;
- radio telephony;
- the transmission of data signals.

METHOD AND DEVICE FOR RECEIVING AT LEAST TWO RECEPTION PATHS, AND CORRESPONDING USE

The field of the invention is that of the reception of digital signals, in the field of receivers implementing at least two distinct reception paths, namely two paths supplied with distinct data flows but conveying (at least partially) the same source symbols.

Thus, the invention can be applied especially to receivers implementing antenna diversity, each antenna receiving the same sent signal but with possibly different disturbances, the transmission channels being distinct. More generally, the invention can be applied in all cases where two distinct data flows bearing the same source symbols are available (whether these flows are similar or transmitted on different frequency bands and/or channels, encoded and/or modulated in different ways, etc.).

A particular field of application of the invention is that of the RF broadcasting of digital television signals (for example according to the DVB-T standard under development or the dTTb project), especially to mobile or portable receivers.

In this situation, it has already been proposed to use antenna diversity techniques. These techniques rely on the simultaneous reception, at several antennas, of one and the same sent signal. It is hoped that, as compared with a single antenna receiver (without diversity of antennas), not all the paths will undergo the same disturbances linked to the transmission channel and, therefore, that it will become possible to achieve a more satisfactory decoding of the signal obtained by recombining the signals present at each antenna.

This recombination is done by "weighting-summation", namely by computing, at each instant, a linear combination of the signals coming from each antenna. This can be done by several approaches which are distinguished by the associating weighting combining mode.

The equal gain combining (EGC) technique summates the signals in phase, the selection combining (SC) technique selects the signal with the highest signal-to-noise ratio, the maximum ratio combining (MRC) technique weights the signals by the ratio of the amplitude or their attenuation and the power of the additive noise that the channel makes them undergo before summating them in phase.

There are also approaches that implement a gradient-type adaptive filtering (also used in equalization) but they are considered to be complex to perfect and finalize and far too slow in their convergence for very many applications.

The maximum ratio combining (MRC) technique maximizes (on the assumption of signals undergoing an attenuation - related to the channel - and an additional noise - related to the first amplification stages – that are independent) the mean signal-to-noise ratio obtained after recombination and leads to results better than those of the EGC and SC techniques. It is this technique that is generally preferred for use.

The literature contains many examples of transmission systems using antenna diversity. According to these prior art techniques, the "weighting-summation" operation is achieved before demodulation or even before processing by the tuner (in radio frequencies or RF) so that the receiver thus obtained contains at most only one tuner, this tuner being a costly component.

This approach is relatively well suited to the case of narrow-band signals (namely cases that substantially undergo the same attenuation throughout their passband). Thus, the document U.S. 5,553,102 describes an implementation thereof, in the context of a single-carrier signal. According to this technique, the MRC combination delivers binary decisions. The use of these techniques on two wide-band signals on the contrary may prove to be highly sub-optimal, especially owing to the risk of fading or selective disturbances that affect only a part of the concerned frequency band.

Furthermore, since the MRC technique requires an estimation of the channel and the phasing of the signals, its use is often relinquished for the SC technique. However, in all cases, a problem may arise of the synchronization of the demodulator during the switching over from one reception path to the other.

There is also the known document, "Antenna Diversity for Digital Video Broadcasting" (J.G.W. Janssen et al. - document dTTb/WP3.2/Philips/24), that describes a system carrying out a recombination by selection after multicarrier demodulation (OFDM demodulation). This technique proves to be inefficient in practice and its development has not been pursued.

It is a goal of the invention in particular to overcome these drawbacks of the prior art.

More specifically, it is a goal of the invention to provide a device and a method of reception using at least two reception paths, for example in the form of a diversity of antennas, that are more efficient in terms of recombination quality, and hence of final decoding, than prior art techniques, especially for wideband signals.

Another goal of the invention is to provide a device of this kind and a method of this kind that are simple to implement without requiring any complex adaptation of the structures of known receivers.

In particular, it is a goal of the invention to provide a device and a method of this kind using information already available in receivers, said device and method being in conformity with the standards that are being developed.

These goals and others that shall appear hereinafter are achieved according to the invention by means of a reception device implementing at least two reception paths supplied with data flows, each conveying the same source symbols, each of said paths comprising estimation means, associating, with each source symbol received, an estimated path value and a corresponding path confidence information element. According to the invention, this reception device comprises means for the combination of said estimated path values into an adapted estimated value, said combination taking account of said path confidence information elements to weight said estimated path values.

Thus, according to the invention, the "weighting-combination" operations are performed just before the weighted-input decoding. The result is optimized since it takes account of the confidence information elements. The technique is simple to implement, as the exploited information elements are already available in the receiver.

Advantageously, said estimation means comprise means for the estimation of the transmission channel, delivering said path confidence information elements.

It is clear however that other types of confidence information elements may be used.

Preferably, said combination means associate an adapted confidence information element with each of said adapted estimated values, as a function of said path confidence information elements. These information elements then supply the weighted-inputs decoder.

According to a preferred embodiment of the invention, said adapted estimated value is computed as follows:

$$\hat{x}_{Adap,n} = \left(\sum_{i=1}^{N} cnfd_{i,n} \times \hat{x}_{i,n} \right) / \left(\sum_{i=1}^{N} cnfd_{i,n} \right)$$

where:

$\hat{x}_n$ is the estimated value of the symbol received on the path i;

$cnfd_{i,n}$ is the corresponding path confidence information element; and

N is the number of paths.

In this case, said adaptive confidence information element may advantageously be computed as follows:

$$cnfd_{Adap,n} = \sum_{i=1}^{N} cnfd_{i,n}$$

where:

$cnfd_{i,n}$ is the confidence information element associated with the path i; and

N is the number of paths.

The data flows according to the invention may be of different types. According to one preferred embodiment of the invention, at least one of said data flows is transmitted by means of a multicarrier modulation.

Indeed, as shall be seen hereinafter, the invention is particularly well suited to this type of modulation.

In this case, said source symbols may be conveyed by a subset of the set of carriers implemented by said multicarrier modulation.

According to an advantageous embodiment of the invention, the device implements at least two antennas (antenna diversity) supplying distinct reception paths.

The invention is especially well suited to devices having a general three-level structure:

- a first module shaping and demodulating the received signal for each of said reception paths;

- a second module, for each of said reception paths, determining said estimated path values and said corresponding confidence information elements;

- a third single module supplied by said second modules, and carrying out especially the combination, delivering said adapted estimated values and a weighted-input decoding supplied by said adapted estimated values.

The invention also relates to the method of reception implemented by the device described here above.

A method of this kind that implements at least two reception paths supplied by data flows each conveying the same source symbols, each of said paths implementing a step of estimation of the transmission channel, associating an estimated path value and a corresponding path confidence information element with each source symbol received, comprises according to the invention a step for the combination of said estimated values of paths delivered by each of said paths into an

adapted estimated value, said combination taking account of said path confidence information to weight said estimated path values.

The invention also relates to the use of a device and/or of the method described here above, especially for the reception of data belonging to at least one of the following applications:

- the broadcasting of digital television signals;
- the broadcasting of audio-digital signals;
- radio telephony;
- the transmission of data signals.

Other features and advantages of the invention shall appear more clearly from the following description of a preferred embodiment of the invention, given by way of a simple illustrative and non-restricted example, and from the appended single figure. This figure shows a simplified block diagram of a receiver in the special case of a COFDM modulation and a two-antenna diversity (only the processing of the carrier k being illustrated).

As indicated here above, an essential characteristic of the invention is the exploitation of the information elements intended for a weighted-input decoder that is present in the rest of the processing chain. Here below, we shall rapidly recall the principle of this technique.

Let $\hat{x}_n$ be an estimation of the nth symbol to be decoded and $cnfd_n$ a measurement of confidence in this estimation. The term "weighted-input decoding" designates any system of decoding which, on the basis of a set of pairs $\{(\hat{x}_n, cnfd_n)\}_n$, finally decodes a set of symbols $\{\hat{c}_n\}_n$ in seeking to minimize:

$$\sum_n cnfd_n \times dist(\hat{c}_n - \hat{x}_n) \qquad (1)$$

where *dist* is a distance.

A decoder of this kind is often used for the decoding of error corrector codes and is used for example for the soft-decision decoding of a convolutive code. It is most usually made in the form of a Viterbi decoder (used to optimize the equation (1) with reduced complexity).

One of the particular features of the invention is that it carries out the operation of "weighting-summation" of the different paths just before this weighted-input decoding, hence after the passage into the tuner, after an estimation of the channel if any and, above all, after a separation of the carriers achieved by a possible multicarrier demodulation. This has several advantages:

- it makes it possible, during the recombination of the signals coming from the different antennas, to work on the already demodulated signals (no problem of synchronization or rephasing of the signals appears in this case) and to take advantage of the information given by a channel estimation, if any;

- when a multicarrier modulation is used and even in the case of the transmission of a wideband signal (needed for example to transmit the high bit rates needed for the transmission of digital television signals), it makes it possible to work on narrow-band signals.

According to the invention, the recombination is done by means of an adapter placed at input of the weighted-input decoder. This adapter makes use of the confidence information allocated to each estimation delivered by each path, to give the weighted-input decoder a total optimized estimation (adapted estimation) itself affected by an adapted confidence information element.

Thus, the weighting selectively affects each received signal (and not the totality of the signal). No additional information, as compared with a conventional receiver, is necessary.

As will be seen in the example described here above, this approach is well suited to multicarrier systems, the data borne by each carrier being weighted independently. It is clear however that it can be applied also to single-carrier systems.

The single figure shows a simplified block diagram of a COFDM modulation receiver implementing a two-antenna diversity. It is easy to generalize this principle to more than two antennas and more generally to two or more paths as defined here above.

The term COFDM is understood to mean especially, in this embodiment, the association of a convolutive code (known as an internal code), a block code (called an external code) an a multicarrier OFDM modulation. An example of such a system is described for RF digital television broadcasting in the DVB-T standard (see for example the ESTI document "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television (DVB-T)", ETS draft, 3000744, March 1997).

Hereinafter, for reasons of simplification, we shall describe only the processing of the nth symbol sent, borne by the carrier k, namely $x_k(n)$.

The receiver has two paths 10_1 and 10_2, each having an antenna 101_1, 101_2 and a tuner 102_1, 102_2, an analog-digital converter ADC 103_1, 103_2, a multicarrier demodulation module 104_1, 104_2 and an estimation module 105_1, 105_2.

These different details are known, and it is not necessary to describe them in greater detail. The symbol $x_1(n)$ is received by each of the antennas and processed independently by each of the paths 10_1 and 10_2. Thus, each of the demodulation modules 104_1, 104_2 delivers the corresponding information $y_{1,k}(n)$ and $y_{2,k}(n)$, from which the estimation modules 105_1 and 105_2 produce:

- a path estimation : $\hat{x}_{1,k}(n)$and $\hat{x}_{2,k}(n)$;
- a path confidence information element: $cnfd_{1,k}(n)$ and $cnfd_{2,k}(n)$.

In other words, the signal at output of each antenna undergoes all the conversions carried out by a standard receiver up to (but not including) weighted-input decoding. Then, for each path i, there is obtained a noise-ridden estimate $\hat{x}_{i,k}(n)$ of the symbols transmitted on the channel and a value of confidence $cnfd_{i,k}(n)$ in this estimation.

Reference may be made to the document dTTb Module 3 (dTTb/M3/284 "System Specification for the Second dTTb Demonstrator", dTTb Module 3, Version 2.2, February 1996), and to the DVB-T standard for an exemplary mode of computation of these confidence values and estimations as well as the implementation of the associated weighted-input decoding.

The information elements $\hat{x}_{i,k}(n)$ and $cnfd_{i,k}(n)$ are fed into an adaptation module 11, a new element according to the invention, which gives the weighted-input decoder 12 an estimation and an adapted confidence value (optimized).

Since the decoding works synchronously on each path, an improved estimation of the symbols transmitted on the channel $\hat{x}_{Adap,k}(n)$ is obtained by computing the sum of the estimations obtained previously, weighted by their respective confidence values. The confidence value $cnfd_{Adap,k}(n)$ associated with this estimation is equal to the sum of the confidence values.

The adapter 11 therefore carries out the following operations:

$$\left.\begin{array}{l} cnfd_{Adap,k}(n) = \sum_i cnfd_{i,k}(n) \\ \hat{x}_{Adap,k}(n) = \left(\sum_i cnfd_{i,k}(n) \times \hat{x}_{i,k}(n)\right) \Big/ \left(\sum_i cnfd_{i,k}(n)\right) \end{array}\right] \forall k \text{ carrier}, \forall n \text{ integer}$$

Naturally, this is only an example and other weighting methods may be used. It is also possible to take account of other information elements (representing for

example the type of data, a specific quality of a channel, an error rate, etc.) to optimize these operations.

Then, the weighted input decoder 12 conventionally decodes the internal code. Again conventionally, the processing continues with the decoding of the external code 13 and then the source decoding 14.

In the particular case of a standard Viterbi decoding that does not take account of the estimation of the channel, resorting to a soft decision is equivalent to the use of an estimated "hard" value of the symbol transmitted, associated with a measurement of confidence in this estimation. This confidence is then, for example, a function of the (assumed) relationship of the noise affecting the transmission and of the distance between the estimated "soft" value and the estimated "hard" value chosen.

Thus, the notion of "estimated path value" according to the invention can be, without distinction, soft or hard. Furthermore, the confidence information may be of any appropriate type and not exclusively from a channel estimation.

As already stated, the invention can be applied to all situations where several paths have to be processed, especially for the processing of P of N data fluxes processed, coming from a signal transmitted by multicarrier modulation (distinct or not distinct for each flow) and containing the information conveyed by a subset (not necessarily identical for each flow) of all the carriers implemented in this signal.

CLAIMS

1. Device for the reception of a multicarrier signal, formed by a set of carrier frequencies, said device implementing at least two reception paths (10_1 and 10_2) supplied with data flows, each conveying the same source symbols, each of said paths comprising estimation means (105_1, 105_2), associating, with each source symbol received, an estimated path value and a corresponding piece of path confidence information

a source symbol being conveyed by a subset of said set of carrier frequencies,

characterized in that it comprises means for the combination (11) of said estimated path values delivering

- an adapted estimated value, obtained from said estimated path values, in taking account of said path confidence information to weight said estimated path values; and
- an adapted confidence information element, as a function of said path confidence information elements,

weighted-input decoding means (12) supplied by said adapted estimated values.

2. Reception device according to claim 1, characterized in that said estimation means (105_1, 105_2) comprise means for the estimation of the transmission channel, delivering said path confidence information elements.

3. Reception device according to any of the claims 1 and 2, characterized in that said adapted estimated value is computed as follows:

$$\hat{x}_{Adap,n} = \left(\sum_{i=1}^{N} cnfd_{i,n} \times \hat{x}_{i,n} \right) / \left(\sum_{i=1}^{N} cnfd_{i,n} \right)$$

where:

$\hat{x}_n$ is the estimated value of the symbol received on the path i;

$cnfd_{i,n}$ is the corresponding path confidence information element; and

N is the number of paths.

4. Reception device according to any of the claims 1 to 3, characterized in that, said adaptive confidence information element is computed as follows:

$$cnfd_{Adap,n} = \sum_{i=1}^{N} cnfd_{i,n}$$

where:

$cnfd_{i,n}$ is the confidence information element associated with the path i; and

N is the number of paths.

5. Reception device according to any of the claims 1 to 4, characterized in that it implements at least two antennas (101_1, 101_2), supplying distinct reception paths.

6. Reception device according to any of the claims 1 to 5, characterized in that each of said reception paths comprises a first module shaping and demodulating the received signal and a second module determining said estimated path values and said corresponding confidence information elements,

said device furthermore comprising a single module supplied by said second modules, and providing especially for the combination (11) delivering said adapted estimated values and a weighted-input decoding (12) supplied by said adapted estimated values.

7. Method for the reception of a multicarrier signal, formed by a set of carrier frequencies transmitted simultaneously, implementing at least two reception paths supplied with data flows, each conveying the same source symbols, each of said paths implementing a step of estimation of the transmission channel associating, with each source symbol received, an estimated path value and a corresponding path confidence information element,

a source symbol being conveyed by a subset of said set of carrier frequencies,

characterized in that it comprises:

- a combination step delivering:
  - an adapted estimated value, obtained from said estimated path values in taking account of said path confidence information to weight said estimated path values ; and
  - an adapted confidence information element with each of said adapted estimated values, as a function of said path confidence information elements,
- a step of weighted-input decoding, supplied by said adapted estimated values.

8. Use of a device and/or of the method according to any of the claims 1 to 6 and/or of the method according to claim 7, for the reception of data belonging to at least one of the following applications:

- the broadcasting of digital television signals;
- the broadcasting of audio-digital signals;
- radio telephony;
- the transmission of data signals.

ABSTRACT OF THE DISCLOSURE

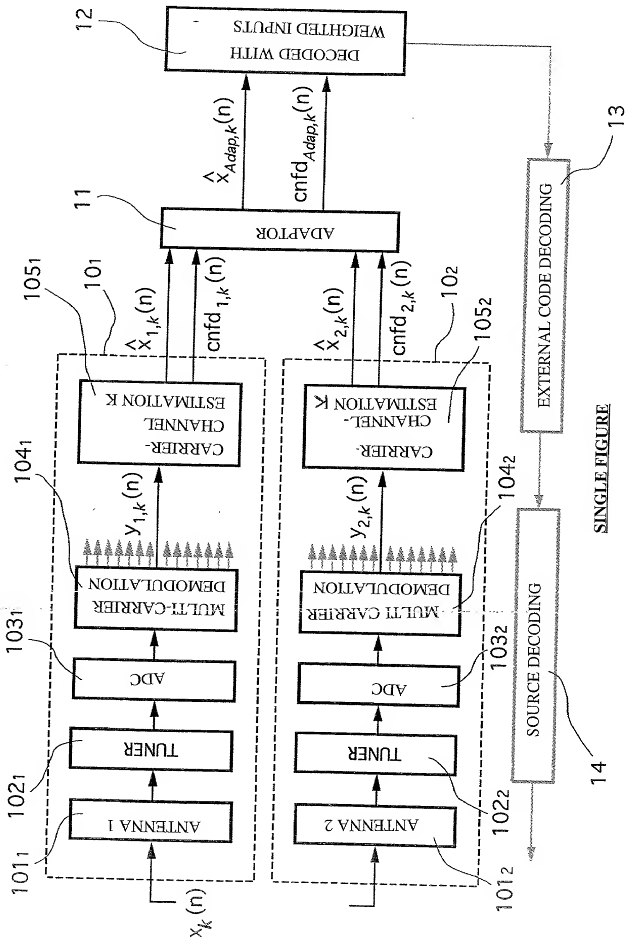
METHOD AND DEVICE FOR RECEIVING AT LEAST TWO RECEPTION PATHS, AND CORRESPONDING USE

The invention relates to a reception device implementing at least two reception paths supplied with data flows, each conveying the same source symbols, each of said paths comprising estimation means, associating, with each source symbol received, an estimated path value and a corresponding path confidence information element, and comprising means for the combination of said estimated path values into an adapted estimated value, said combination taking account of said path confidence information elements to weight said estimated path values. Said estimation means advantageously comprises means for the estimation of the transmission channel, delivering said path confidence information elements. Said combination means may advantageously associate an adapted confidence information element with each of said adapted estimated values, as a function of said path confidence information elements.

Single Figure

Inventor LAGNA? et al
Docket No. 9320.127USWO
Title METHOD AND DEVICE FOR RECEIVING ...
Attorney Name John J G...s
Phone No 612 371 52...
Sheet 1 of 1

09/830232



SINGLE FIGURE

Attorney Docket No. 9320.127USWO

03125
2001

MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: METHOD AND DEVICE FOR RECEIVING AT LEAST TWO RECEPTION PATHS, AND CORRESPONDING USE

The specification of which
a. ☐ is attached hereto
b. ☒ was filed on as application serial no. and was amended on (if applicable) (in the case of a PCT-filed application) described and claimed in international no. PCT/FR/02799 filed November 15, 1999 and as amended on November 14, 2000 (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**
France	98 14438	13 November 1998	

ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. APPLICATION NUMBER	**DATE OF FILING (day, month, year)**	**STATUS (patented, pending, abandoned)**

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

U.S. PROVISIONAL APPLICATION NUMBER	**DATE OF FILING** (Day, Month, Year)

I acknowledge the duty to disclose information that is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (reprinted below):

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

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Edell, Robert T.	Reg. No. 20,187	Schumann, Michael D.	Reg. No. 30,422
Epp Ryan, Sandra	Reg. No. 39,667	Scull, Timothy B.	Reg. No. 42,137
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Kettelberger, Denise	Reg. No. 33,924	Whitaker, John E.	Reg. No. 42,222
Keys, Jeramie J.	Reg. No. 42,724	Wickhem, J. Scot	Reg. No. 41,376
Knearl, Homer L.	Reg. No. 21,197	Williams, Douglas J.	Reg. No. 27,054
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I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Merchant & Gould P.C. to the contrary.

I understand that the execution of this document, and the grant of a power of attorney, does not in itself establish an attorney-client relationship between the undersigned and the law firm Merchant & Gould P.C., or any of its attorneys.

Please direct all correspondence in this case to Merchant & Gould P.C. at the address indicated below:

Merchant & Gould P.C.
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Minneapolis, MN 55402-0903

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Signature of Inventor 203:				**Date:**